(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 658 452 A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 94119126.4

(22) Date of filing: 05.12.94

(51) Int. Cl.[6]: B60C 19/08, B60C 1/00

(30) Priority: 14.12.93 IT MI932615

(43) Date of publication of application: 21.06.95 Bulletin 95/25

(84) Designated Contracting States: CH DE ES FR GB LI

(71) Applicant: PIRELLI COORDINAMENTO PNEUMATICI S.p.A.
Viale Sarca, 222
I-20126 Milano (IT)

(72) Inventor: Boiocchi, Maurizio
Piazza della Repubblica, 6
Segrate (MI) (IT)
Inventor: Nahmias, Marco
Via della Moscova, 44/1
Milan (IT)

(74) Representative: Giannesi, Pier Giovanni et al
Pirelli S.p.A.
Direzione Proprietà Industriale
Viale Sarca, 222
I-20126 Milano (IT)

(54) Antistatic tyre having low-carbon black blends.

(57) In a vehicle tyre provided with a tread band (9) made of a low-carbon black blend, one or more conductive inserts (12) of an elastomeric material having a high carbon black content are provided, which inserts are incorporated in the tread band and extend in an annular configuration along the whole circumferential extension of the tread band. Each conductive insert (12) passes through the whole tread thickness and is exposed externally of the rolling surface (9a) of the tread band itself, acting by its opposite side (12b) in contact relationship on the belt (6), the carcass ply (2) or another tyre part having sufficient electric conductivity to enable the electrostatic charges stored by the vehicle on running to be discharged to the ground through the tyre via the conductive inserts themselves.

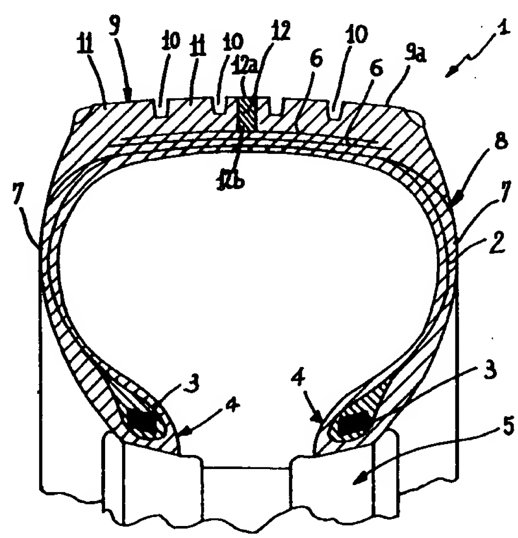

FIG.1

EP 0 658 452 A1

The pr sent inv ntion r lat s to an antistatic tyre the tread band of which has a low carbon black cont nt, of the type comprising at least ne carcass ply anchored, at respective pposit edg s thereof, to a pair of bead cores arranged in corresponding beads defined along the inner circumferential edges of said tyre; at least one belt layer xtending circumferentially about said carcass ply; a tread band disposed circumferentially about the belt layer and externally exhibiting a rolling surface designed to come into contact with the ground.

It is known that vehicle tyres in general oust have, in addition to usual roadholding and ride comfort features, also a certain degree of electric conductivity so that the electrostatic charges inevitably stored by the vehicle on running may be conveniently discharged to the ground, at least within some limits.

In the connection, there are several different regulations for classifying the tyres depending on th electric resistivity they show and/or fixing the maximum resistivity limits that the tyres must exhibit based on the intended uses. By way of example, the German regulation of the WIRTSCHAFTSVERBAND DER DEUTSCHEN KAUTSCHUKINDUSTRIE E.V. (W.d.K. Leitlinie 110) classifies tyres into two different classes, identifying in the first class tyres having an electric resistance lower than 10^6 ohm, and in the second class tyres having an lectric resistance lower than 10^8 ohm. Still by way f example, according to BSI (British Standards Institution) regulations BS 2050:1978 tyres used at the inside of hospitals must have an electric resistance value lower than 10^4 ohm. Still in accordance with these regulations, tyres used on industrial vehicles designed to carry explosives must not have an electric resistance higher than 5×10^5 ohm.

In tyres of earlier conception, for example those disclosed in US Patent No. 2,339,546, the necessary tyre conductivity was ensured by a particularly conductive rubber strip extending from the radially outer surface of the tread to the tyre bead, where it came into direct contact with the mounting rim located between the outermost carcass ply and the outer surface of the tyre.

Such a solution has not been in use for a long time and it was hardly used in the past because of th construction complications generated during th tyre manufacture and the problems relating to the qualitative features of the finished product as a consequence of unevennesses caused by the pres nce of said strip in the carcass structure.

Consequently, in the tyres that are presently commonly used and commercialized, th requisit lectric conductivity is nsured by the pres nc of th carbon black normally used as a reinforcing fill r in th bl nds forming the differ nt tyr parts.

In this r spect, th tyr manufacturers' fforts have been tendentially ori nted towards researches aiming at finding ut th modalities for use of carbon black in ord r to achi ve th requisite lectric conductivity values. For example, Patent FR 793,507 describes a blend made conductive by an appropriate selection of the characteristics of the carbon black introduced thereinto. Patent US 4,642,202 discloses a process for preparing conductive rubbers having a resistivity lower than 10 ohm*cm, consisting in adding to a normal blend formulation a composition formed of at least one material having a low compatibility with rubber and mixed with a highly conductive material such as some specific types of carbon black or metal powders. Patent US 5,173,135 describes a radial tyre for motor vehicles, the sidewalls of which are made of a blend consisting of an elastomeric material containing conductive black.

In tyres of the above type the electrostatic charges stored in the vehicle bodywork on running are transferred to the tyre itself through the wheel rim and completely cross the tyre structure moving through the carbon black aggregates present in the polymeric matrix of the elastomeric material to be ultimately transferred to the ground at the contact area between the rolling surface of the tread band and the ground itself.

Under this situation, the electric resistance value detectable on the above tyres can vary depending on the quantity and type of carbon black introduced into the blends forming the different parts of the tyre from a minimum of 10^2 ohm to a maximum of 10^6 ohm, and this value is therefore capable of complying with most requirements.

It is pointed out that all resistivity and electric resistance values cited in the present description are intended as measured according to UNI 4288-71 Standard.

The foregoing being stated, it is noted that tyres to be used in particular on motor-vehicles have been recently developed the tread band of which is made of a blend in which carbon black is containted in minimum or even negligible amounts, being for example completely or mostly replaced by silicon-based reinforcing fillers, such as silicon oxides or several different types of silicates for example. In the following such reinforcing fillers will be generally referred to as "silicon".

The fundamental property of tyres thus conceived is a remarkably reduced rolling resistance as compared to the resistance that can be found in tyr s with a tread band having a high carbon black c nt nt, in that th use of silicon-based r inforcing fill rs instead of carbon-containing fill rs giv s th bl nd bett r hysteretic f atures.

It has been found how v r that a carbon black reduction in th bl nd forming the tread band or a

compl t elimination th reof involv s an important and on the other hand undesired increas in the electric resistance of th tyr , in that th conductiv bridges supplied by th carbon present in carbon black are missing.

The electrostatic charges produced in the vehicle on running therefore cannot be conveniently discharged to the ground and tend to be stored, thereby reaching very high potentials.

Under this situation at the moment that the vehicle is touched by a person or an object creating a conductive connection between the vehicle and ground, the electrostatic energy previously stored is completely and suddenly discharged thereby producing an electric discharge of high potential, presently estimated in the order of 25 KV. On the contrary its intensity is deemed to be very low, in the order of milli-ampere.

These electric discharges, besides being very bothersome when they occur to a person who is touching the motor-vehicle, also constitute a factor of great danger as regards supply operations taking into account the fact that the discharge can take place between the motor-vehicle bodywork and the fuel delivery gun.

It is also to note that storage of the electrostatic charges in a running vehicle also gives rise to frequent electric discharges between different parts of the vehicle, causing unacceptable operating noise in the radio sets and/or any other electric or electronic apparatus installed on board of the vehicle.

According to the present invention, it has been found that the electric resistance of a tyre with a tread band having a low carbon black content and high silicon (or other non conductive filler) content can be greatly reduced and brought to the requisite values if at least one conductive insert preferably extending over the whole circumferential extension of the tyre is associated with the tread band, said insert being such arranged and passing through the whole tread band thickness in such a manner that it performs the function of a conductive connection between the ground and one of the belt layers or the carcass ply, or a sidewall or another sufficiently conductive part of the tyre.

The invention relates to an antistatic tyre, in particular having a low rolling resistance, characterized in that it further comprises at least one conductive insert made of an elastomeric material incorporated in the tread band and extending through the whole tread band thickness, being then exposed ext mally of the rolling surface, the lastomeric mat rial forming th conductiv insert xhibiting an lectric resistivity lower than that of th lastomeric material forming the tread band, in ord r to incr ase th lectric conductivity between the ground and th tyr .

Advantageously, th conductiv insert xhibits an inn r nd that, depending on cases, can be arranged in contact relationship with th belt lay r, th carcass ply or th elastom ric mat rial forming one tyre sidewall, extending externally of the carcass ply from said bead to a corresponding side edge of the tread band.

Preferably, the conductive insert extends over the whole circumferential extension of the tread band and, in one embodiment, is located at a centered position relative to the equatorial plane of the tyre and exhibits a width, measured parallelly of the tyre axis, included between 2 mm and 40 mm.

In a second embodiment the tyre comprises at least two of said conductive inserts, located at symmetrically spaced apart positions relative to an equatorial plane of the tyre, each adjacent to one of the side edges of the tread band.

In addition, at least at the rolling surface the extension of each conductive insert is provided to be broken by transverse cut-outs formed in the tread band to define respective blocks in said rolling surface. In this case the conductive inserts should be preferably associated with respective rows of mutually offset blocks so that at least one of the inserts is always in contact with the ground.

In the presence of two or more conductive inserts, the sum of the insert widths measured parallelly of the tyre axis, is preferably included between 4 mm and 50 mm.

Advantageously, the elastomeric material forming the conductive insert containing carbon black-based reinforcing fillers has an electric resistivity lower than 10^3 Kohm*m, whereas the elastomeric material forming the tread band containing silicon-based reinforcing fillers has an electric resistivity greater than 10^6 Kohm*m.

At all events and to best advantage, the following proportion is to be taken into account: the greater the resistivity of the material forming the tread band is, the lower the resistivity of the blend forming the conductive insert.

Further features and advantages will become more apparent from the detailed description of some preferred embodiments of an antistatic tyre made of blends having a low carbon black content, according to the present invention, given hereinafter by way of non-limiting example with reference to the accompanying drawings, in which:

- Fig. 1 is a fragmentary cross sectional view of one embodiment of a tyre according to the invention;
- Fig. 2 is a fragmentary cross sectional vi w of a second mbodim nt of the tyr in ref rence.

R f rring to th drawings, an antistatic tyr in accordance with the pr sent invention has been

gen rally id ntified by refer nc num ral 1.

Conv ntionally tyr 1 comprises at least on carcass ply 2 the opposit sid edges of which ar folded up around corresponding anchoring bead cores 3, each incorporated in a bead 4 defined along an inner circumferential edge of the tyre at which the engagement of the tyre itself on a mounting rim 5 being part of a vehicle wheel takes place.

Applied to the carcass ply 2 along the circumferential extension thereof is one or more belt lay- rs 6 made of textile or metal cords incorporated in a blend sheet.

Also applied to the external surface of the carcass ply 2 at respective opposite side positions thereof is a pair of sidewalls 7 each of which substantially extends from the bead 4 until the so-called "shoulder" region 8 of the tyre, defined in the vicinity of the end edges of the belt layers 6.

To the ends of the present invention, the lastomeric material blends employed in making th sidewalls 7, belt layers 6 and carcass ply 2 respectively may advantageously be of a high-carbon black type, so as to exhibitin an electric r sistivity not exceeding 10^3 Kohm*m.

A tread band 9 is circumferentially disposed around the belt layers 6, the side edges of said tread band terminating at the shoulders 8 and being connected to the sidewalls 7. The tread band 9 externally exhibits a rolling surface 9a arranged to act in contact relationship on the ground, in which surface circumferential grooves 10 alternating with the transverse cut-outs may be formed. Said grooves are not shown in the accompanying figures and they define a plurality of blocks 11 distributed in one or more circumferential rows 2.

In the tyre 1 made in accordance with the present invention, the tread band 9 is made of an lastomeric material blend in which the carbon black, usually employed as the reinforcing filler in the remaining parts of the tyre itself, is completely or almost completely replaced by a silicon or another non conductive material adapted to improve th hysteretic features of the tread band and, as a result, reduce the tyre rolling resistance under use conditions. The presence of silicon in place of carbon black however involves an increase in the lectric resistivity of the blend forming the tread band the value of which may easily exceed 10^6 Kohm*m.

According to the present invention, problems r sulting from the high resistivity of the low-carbon black blend forming the tread band 9 are solved by arranging at least on conductiv insert 12 in th tread band itself, which insert is pr f rably made of an lastomeric material having an electric resistivity low r than that of th elastom ric material forming the tr ad band. The conductiv insert 12 pr f rably xt nding according to th whol circumf r ntial extension of the tyre 1, cross s th tr ad band 9 through th whol thickn ss th reof so as to xhibit on out r nd 12a xposed to the utsid which is flush with the rolling surface 9a in order to get into contact relation with the ground, so that the electric conductivity between the ground and the tyre will be increased. The conductive insert 12, on its side opposite to the outer end 12a has an inner end 12b that, depending on cases, can be arranged in contact relationship with one of the sidewalls 7 of the tyre or any other tyre part having an electric conductivity sufficient to ensure a good conductive connection between the ground and the rim 5 and therefore the vehicle bodywork, through the tyre 1.

In order to ensure a good conductive connection between the tyre 1 and the ground through the tread band 9, the conductive insert 12 is provided to be made of elastomeric material-based blends having an electric resistivity lower than 10^3 Kohm*m, preferably achieved through the use of carbon black reinforcing fillers in said blends. Should the electric resistivity of the tread band be equal to or higher than 10^8 Kohm*m, the conductive insert would preferably have an electric resistivity lower than 100 Kohm*m or equal thereto. At all events, in general terms, the greater the electric resistivity of the parts of the tread band 9 other than the conductive insert 12, the lower the electric resistivity to be given to said insert.

The Applicant deems it suitable to this end to observe the rule of coupling blends for treads and blends for conductive inserts the resistivity values of which, measured in Kohm*m, are such conceived that the algebraic sum of the respective exponents does not exceed 11; for example, in the above case where values are exactly 10^8 and 10^2, one has $8+2=10$. By modifying the axial size of the insert it will be then possible to give the tyre the desired electric resistance value minimizing the noise effect caused by the presence of the insert itself in the tread band.

Referring particularly to Fig. 1, the example therein shown contemplates the presence of a single conductive insert 12 located at a centered position relative to the equatorial plane of the tyre 1. In this case, the conductive insert 12 preferentially has a width, measured parallel to the tyre axis, included between 2 mm and 40 mm. Lower or higher width values than the above could give rise to a weak reliability in the conductive connection with the ground or an excessive influence of the conductive insert on the tyre rolling resistance, r spectiv ly.

Still r f rring to Fig. 1, th inn r nd 12b of th conductive insert 12 acts in contact relationship on the out rmost on of th belt lay rs 6. Und r this situation, th lectric connection between th con-

ductiv insert 12 and rim 5 can advantageously tak plac through th metal cords optionally arranged in th belt lay r 6 and carcass ply 2, or through th low-resistivity lastom ric mat rial mployed in making the plies themselves.

We refer now to Fig. 2. In the tyre therein shown the presence of at least two conductive inserts 12 is provided and they are placed at symmetrically spaced apart positions relative to the tyre equatorial plane. In particular, each of the conductive inserts 12 is located adjacent to one of the side edges of the tread band 9 and its inner end 12b acts in contact relationship on the carcass ply 2 and/or the sidewall blend. Should the circumferential extension of each insert 12 be broken by effect of the presence of said transverse cut-outs in the tread band 9, it would be advantageous to envisage the association of the conductive inserts with corresponding rows of mutually offset blocks 11, so that, at each moment, at least one of the conductive inserts 12 is in contact relationship with the ground. In the above case, in order to ensure the continuous presence of this contact with the ground, it would be convenient for said inserts to be disposed, in respect of the type of tread pattern present on the band, in an asymmetric position relative to the equatorial plane of the tyre.

Alternatively, the use of two conductive inserts disposed on the tyre shoulders symmetrically to the equatorial plane would be convenient, said inserts being in this case made of blends adapted to achieve an evener and more constant wear in these particularly critical tread areas due to the presence of high-silicon blends.

Preferably, in the presence of two or more conductive inserts 12 the sum of the insert widths is provided to be in the range of 4 mm to 50 mm.

The present invention achieves important advantages.

The presence of the conductive inserts 12 in the tread band 9 in fact ensures that the vehicle bodywork on which the tyre in reference is mounted will be constantly connected to the ground, thereby eliminating any problem related to the use of tread bands made of low-carbon black elastomeric materials, as those having a high silicon content.

Note should be also taken of the fact that the electric conduction carried out by utilizing the belt layers 6 and/or carcass layers 2 too, as well as the sidewalls 7 and any other tyre part, advantageously makes it possible to use conductive inserts the extension of which in a radial direction is tightly r strained to th tread band thickn ss without th necessity of using any additional l ments for connecting them to the rim, as th pr sence of said lem nts in th tyr structur could und sirably alter the operating f atures th reof.

. It should be also recognized that, sinc th xt nsion of the conductive insert or ins rts is limited to th tr ad band thickness, said inserts can be directly associated with th tread band during the usual blend extrusion steps carried out for making the tread band itself, without requiring any additional working in the subsequent assembling steps of the different tyre parts.

Obviously modifications and variation may be made to the invention as conceived, all of them falling within the scope of the invention, as defined in the claims.

Claims

1. A vehicle tyre, comprising:
   - at least one carcass ply (2) anchored, at respective opposite edges thereof, to a pair of bead cores (3) arranged in corresponding beads (4) defined along the inner circumferential edges of said tyre (1);
   - at least one belt layer (6) extending circumferentially about said carcass ply (2);
   - a tread band (9) disposed circumferentially about the belt layer (6) and externally exhibiting a rolling surface (9a) designed to come into contact with the ground,

   characterized in that it further comprises at least one conductive insert (12) made of an elastomeric material incorporated in the tread band (9) and extending through the whole tread band thickness, being then exposed externally of the rolling surface (9a), the elastomeric material forming the conductive insert (12) exhibiting an electric resistivity lower than that of the elastomeric material forming the tread band (9), in order to increase the electric conductivity between the ground and the tyre.

2. A tyre according to claim 1, characterized in that said conductive insert (12) exhibits an inner end (12b) in contact with said belt layer (6).

3. A tyre according to claim 1, characterized in that said conductive insert (12) exhibits an inner end (12b) in contact with said carcass ply (2).

4. A tyr according to claim 1, characterized in that said conductiv insert (12) xhibits an inn r nd in contact with th lastom ric material forming on tyr sid wall (7), said sid wall xt nding xt rnally f th carcass ply (2) from said bead (4) t a corresponding sid

edg of th tr ad band (9).

5. A tyr according to claim 1, characterized in that said conductiv ins rt (12) xtends ov r the whole circumferential extension of the tread band (9).

6. A tyre according to claim 5, characterized in that said conductive insert (12) is located at a centered position relative to the equatorial plane of the tyre (1).

7. A tyre according to claim 5, characterized in that it comprises at least two of said conductive inserts (12) located on the opposite sides of said equatorial plane.

8. A tyre according to claim 7, characterized in that said conductive inserts (12) are located at positions spaced apart symmetrically of the equatorial plane of the tyre (1), adjacent to the side edges of the tread band (9).

9. A tyre according to claim 7, characterized in that at least at the rolling surface (9a), the extension of each conductive insert is broken by transverse cut-outs formed in the tread band (9) to define respective blocks (11) in said rolling surface, said conductive inserts (12) being associated with respective rows of mutually offset blocks.

10. A tyre according to claim 5, characterized in that said conductive insert (12) has a width, measured parallelly of the tyre axis, included between 2 mm and 40 mm.

11. A tyre according to claim 7, characterized in that the sum of the conductive insert (12) widths measured parallelly of the tyre axis, is included between 4 mm and 50 mm.

12. A tyre according to claim 1, characterized in that the blend forming the conductive insert has an electric resistivity equal to or lower than 10^3 Kohm*m.

13. A tyre according to claim 12, characterized in that the blend forming the conductive insert (12) contains carbon black-based reinforcing fillers.

14. A tyre according to claim 13, characterized in that th bl nd forming th tread band (9) and th bl nd forming th conductive insert (12) hav such respective electric resistivity values, m asured in Kohm*m, that th alg braic sum of their xpon nts is not high r than 11.

15. A tyr according to claim 1, characterized in that th blend f rming th tr ad band (9) contains r inforcing fill rs of non-conductiv mat rials.

16. A tyre according to claim 15, characterized in that said reinforcing fillers consist of silicon-based materials.

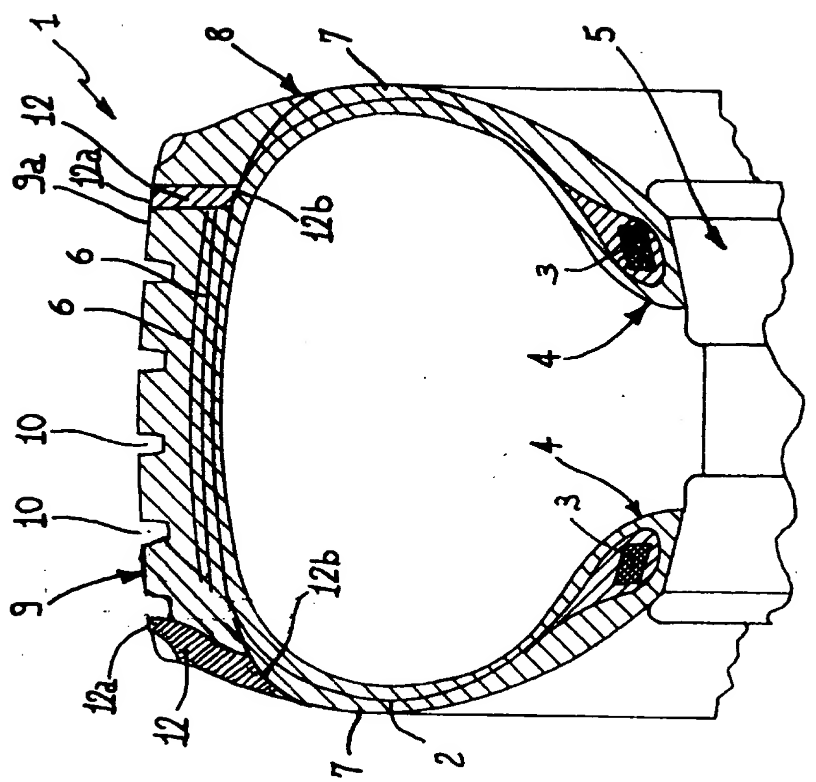
1
8
7
5
12
12a
9a
12b
6
6
10
10
9
3
4
4
3
12b
12a
12
7
2

FIG.2

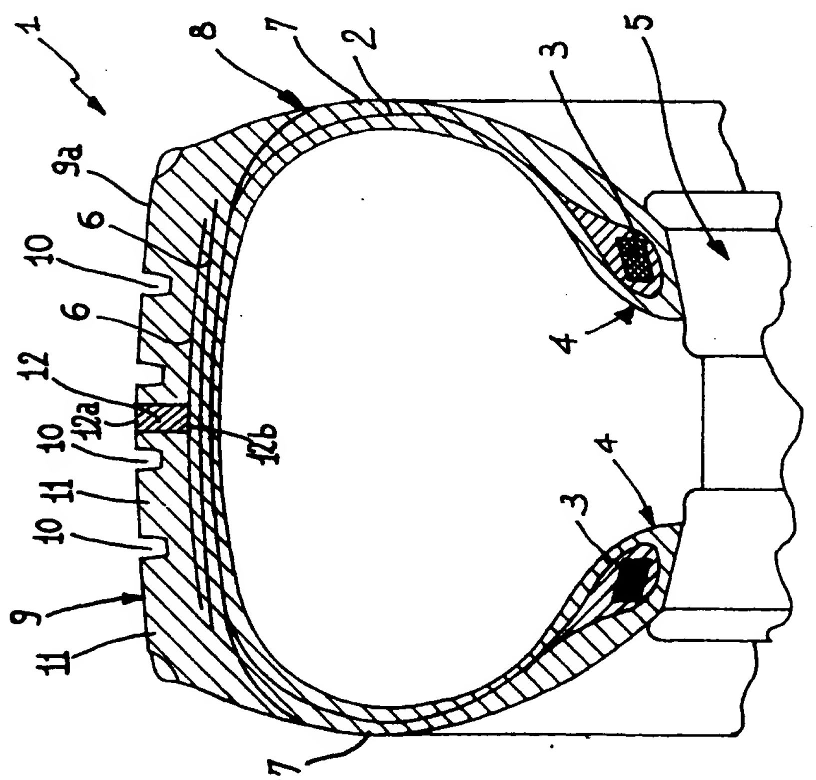
1
8
7
2
3
5
9a
10
6
6
4
12
12a
12b
10
11
10
9
11
4
3
7

FIG.1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 9126

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	GB-A-544 757 (U.S. RUBBER CO.) * page 4, left column, line 25 - page 5, left column, line 25; claims; figures * ---	1-9, 12-14	B60C19/08 B60C1/00
X	GB-A-551 657 (THE FIRESTONE TIRE&RUBBER CO) * page 4, left column, line 26 - right column, line 90; claims; figures * ---	1,4, 10-13	
X	US-A-2 342 576 (J.H. FIELDING) * page 2, left column; claims; figures * ---	1,13,14	
X	DE-C-820 543 (CONTINENTAL AG.) * claims; figures * ---	1,4	
A	FR-A-2 411 719 (BRIDGESTONE TIRE CO. LTD.) * claims; figures * ---	1,13	
A	DATABASE WPI Week 8629, Derwent Publications Ltd., London, GB; AN 86-187702 & JP-A-61 122 003 (SUMITOMO RUBBER IND. LTD.) 10 June 1986 * abstract * ---	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B60C
A	DATABASE WPI Week 8632, Derwent Publications Ltd., London, GB; AN 86-209498 & JP-A-61 143 203 (YOKOHAMA TIRE&RUBBER CO LTD.) 30 June 1986 * abstract * --- -/--	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 March 1995	Baradat, J-L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 9126

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	DATABASE WPI Week 9051, Derwent Publications Ltd., London, GB; AN 90-379997 & JP-A-2 274 740 (TOYO TIRE&RUBBER CO. LTD.) 8 November 1989 * abstract * ---	15,16	
A	DE-A-40 02 628 (YOKOHAMA TIRE&RUBBER CO LTD.) * claims *	1,13	
D,A	& US-A-5 173 135 (CHIGASAGI ET AL.) ---	1	
A	US-A-4 545 927 (RAILSBACK)	1,13	
D,A	& US-A-4 642 202 (...) * claims; tables * -----	1,13	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 March 1995	Baradat, J-L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document